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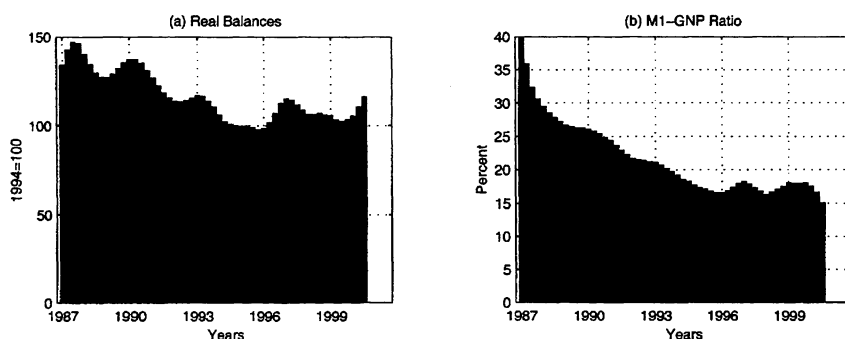
Seigniorage, Currency Substitution, and Inflation in Turkey

It is commonly argued that a high and persistent inflation is caused by a large fiscal deficit and the need for the Government to collect extra seigniorage to finance this deficit. However, a solid link among seigniorage, budget deficit, and inflation has hardly been established in applied studies on the post-World War high-inflation economies, such as Latin American countries or Israel. The evidence from these economies shows that there is no significant upward trend in seigniorage revenue in percent of the gross national product (GNP), although the rate of inflation rises in a stepwise fashion (Bruno 1993; Eckstein and Leiderman 1992).

The Turkish economy is not an exception to this general stylized fact. Figure 1 plots the real balances and the ratio of money stock (M1) to nominal GNP in Turkey between the years 1987 and 2000. Clearly, there was a downward trend in both variables although there was a stepwise increase in inflation during the same period (see Figure 2).¹ There are several hypotheses to explain this observed phenomenon. A well-known approach considers dual equilibrium in the economy. As Sargent and Wallace (1987) and Bruno and Fischer (1990) showed, a given amount of seigniorage revenue may be collected at either a low or a high level of inflation. Hence, there is one “critical level” of inflation at which the government can maximize the seigniorage revenue. Any attempt to raise the seigniorage revenue higher than this critical level by printing money may put the economy into a hyper-inflationary path. Therefore, it is important for a policymaker to obtain some information on the “critical level” of inflation or the shape of the seigniorage Laffer curve.

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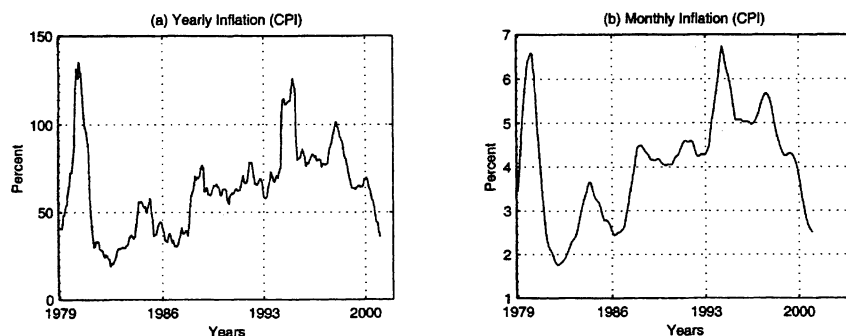
Figure 1. The Real Balances and Velocity



Sources: Central Bank of Turkey (2001); State Institute of Statistics (2001).

Notes: (a) Real money balances, 1994 = 100. Nominal money stock (M1) divided by the consumer price index. (b) M1 Money stock-nominal GNP ratio (percent). Sample: 1987:I–2000:III (quarterly). Both variables are filtered to eliminate strong seasonality.

Figure 2. Inflation in Turkey



Source: State Institute of Statistics (2001).

Notes: (a) Annual inflation, consumer price index (percent). (b) Monthly inflation, CPI (seasonally adjusted, percent). Monthly inflation series are filtered to eliminate strong seasonality.

Conventional studies employ a Cagan-type money-demand function to estimate the critical level of inflation. If the observed inflation rate is less than the estimated seigniorage-maximizing inflation, the economy is said to be on the “correct side” of the seigniorage Laffer curve, that is, there is still room for higher seigniorage at higher inflation rates, and there is an implicit loss of seigniorage revenue if the economy moves to a lower level of inflation. This second implication might be a serious consideration for a

policy maker (and an obstacle to implementing a stabilization program) if the current inflation rate is perceived to be less than the estimated seigniorage-maximizing rate of inflation in the economy.

Another approach to seigniorage-maximization issue considers the fact that domestic residents may substitute a foreign currency for the domestic one when they anticipate a relative increase in the cost of holding domestic real balances. Hence, a high level of currency substitution reduces the government's ability to collect seigniorage revenue, that is, a given budget deficit may be financed with relatively higher inflation. What is more, if domestic residents are very quick in adjusting real balances, the economy may find itself on a hyperinflationary path. Therefore, it is natural to expect a weak relation between seigniorage and inflation, especially in chronic high inflation economies like Turkey.²

In this paper, the effect of currency substitution on seigniorage-maximizing inflation rate in Turkey is examined. Estimates of a money-in-the-utility function model show that the seigniorage-maximizing rate of inflation in Turkey cannot deviate from the world inflation rate since there is a high elasticity of substitution between domestic and foreign currencies and the share of foreign real balances in producing domestic liquidity services is significant. This result is compared with a conventional money-demand estimation. The conventional estimate of the seigniorage-maximizing rate of inflation in Turkey is several times higher than the world inflation rate, and it is grossly misleading since it ignores the possibility of currency substitution.

Simple Cagan-type classical money-demand function estimates are presented in the next section. A money-in-the-utility function model is introduced in the third section. The numerical exercises of Euler equations based on estimated parameters for the Turkish economy are also presented in the same section. The last section contains a brief conclusion.

The Cagan Model

The Cagan-type money-demand function plays a central role in estimating the seigniorage-maximizing inflation rate. It is given by

$$\frac{m_t}{P_t} = \alpha_0 e^{\lambda \left(\frac{\pi_t}{1+\pi_t} \right)^\gamma} y_t^\phi \quad (1)$$

$$\ln \left(\frac{m_t}{P_t} \right) = \ln \alpha_0 + \lambda \left(\frac{\pi_t}{1+\pi_t} \right)^\gamma + \phi \ln y_t, \quad (2)$$

where m is the nominal money supply, p is the price level, y is real income, and π is inflation. Following Calvo and Leiderman (1992), the inflation cost of holding money is taken to be $\pi_t/(1 + \pi_t)$, not just π_t , as it is assumed in almost all conventional studies of money demand in high inflation economies. Semi-elasticity of money demand with respect to inflation is given by

$$\gamma\lambda\left(\frac{\pi_t}{1 + \pi_t}\right)^{\gamma-1}$$

It follows that the necessary condition for the existence of a seigniorage Laffer curve is $\lambda < 0$ and $\gamma > 0$.

Easterly et al. (1995) show that the elasticity of substitution in transactions between money and alternative assets determines how inflation semi-elasticity of money-demand changes as inflation rises, that is, γ in the money-demand function above is usually not equal to one. Based on panel data estimates from eleven high-inflation countries, Easterly et al. (1995) report that semi-elasticity of money-demand increases with increasing inflation, that is, higher inflation causes a flight from money toward alternative assets and strong currencies. They conclude that money-demand estimations based on a constant semi-elasticity assumption might be misleading.

Preliminary estimates of the nonlinear form of the Cagan-type money-demand function of the Turkish economy revealed that γ does not differ significantly from one. Therefore, it was decided to work with a log-linear form of the money-demand function. It is commonly assumed in money-demand estimations that there might be some adjustment lags of actual real balances to the desired level of real balances so that

$$\ln\left(\frac{m_t}{p_t}\right) - \ln\left(\frac{m_{t-1}}{p_{t-1}}\right) = k \left[\ln\left(\frac{m_t}{p_t}\right)^d - \ln\left(\frac{m_{t-1}}{p_{t-1}}\right) \right], \quad (3)$$

where k is the adjustment parameter and $(m_t/p_t)^d$ is the desired level of real balances. Substituting Equation (3) into the money-demand function (Equation (2)) and imposing the restriction $\gamma = 1$ yields the following estimation equation

$$\ln\left(\frac{m_t}{p_t}\right) = b_0 + b_1\left(\frac{\pi_t}{1 + \pi_t}\right) + b_2 \ln y_t + b_3 \ln\left(\frac{m_{t-1}}{p_{t-1}}\right) + \varepsilon_t, \quad (4)$$

where ε_t is a serially uncorrelated white noise disturbance term and the seigniorage-maximizing steady-state inflation rate $\bar{\pi}$ is given by³

$$\frac{\bar{\pi}}{1 + \bar{\pi}} = -\left(\frac{1}{\lambda} + \phi g\right).$$

Equation (4) is estimated in difference form for the sample period of 1988:I–1999:IV. The sample period is restricted because of data availability. Our data set consist of the quarterly consumer price index (CPI) (p), quarterly real GNP (y), end of quarter M1 (m), and quarterly inflation ($p_t = (p_t - p_{t-1})/p_{t-1}$). All variables are in natural logs except for the inflation rate.⁴ The results are

$$\Delta \ln \left(\frac{m_t}{p_t} \right) = -0.798 \Delta \left(\frac{\pi_t}{1 + \pi_t} \right) + 0.213 \Delta \ln y_t + 0.508 \Delta \ln \left(\frac{m_{t-1}}{p_{t-1}} \right) \quad (5)$$

$$R_A^2 = 0.36 \quad DW = 1.72, \quad (6)$$

where Δ is the difference operator ($\Delta x_t = x_t - x_{t-1}$), R_A^2 is adjusted R^2 , and DW is the Durbin-Watson statistic. All of the coefficients are statistically significant at less than 5 percent significance level except for the coefficient of $\Delta \ln y_t$, which has a 10 percent significance level. Estimation results indicate that the seigniorage-maximizing quarterly rate of inflation is approximately 60 percent (over 500 percent yearly!) for the Turkish economy. Given the fact that quarterly inflation in Turkey never exceeded 25 percent (except 1994:II), one may (mistakenly) conclude that the policymakers were on the correct side of the Laffer curve and the government could have collected more seigniorage revenue as a percent of the GNP if they had stimulated inflation by printing more money.

A Money-in-the-Utility Function Model

This section utilizes a simple model of money demand, developed by Imrohoroglu (1996). Similar models were empirically estimated and tested for low inflation or chronic high inflation economies (see for example, Imrohoroglu 1994; Easterly et al. 1995; and Selçuk 1997; among others).

Suppose that an economy consists of infinitely lived identical individuals. At the beginning of each period, a representative agent decides how much to consume c_t , how much to save in the form of internationally traded real bonds b_t^* , how much to hold in the form of domestic real balances m_t/p_t , and foreign real balances m_t^*/p_t^* . This decision is made by maximizing the expected discounted sum of the period-utility function U ,

$$E \sum_{t=0}^{\infty} \beta^t U \left(c_t, \frac{m_t}{p_t}, \frac{m_t^*}{p_t^*} \right), \quad (7)$$

subject to the budget constraint,

$$c_t + \frac{m_t}{p_t} + \frac{m_t^*}{p_t^*} + b_t^* \leq y_t - \tau_t + \frac{m_{t-1}}{p_t} + \frac{m_{t-1}^*}{p_t^*} + (1 + r_{t-1}) b_{t-1}^*, \quad (8)$$

where β is the discount factor and c_t is per capita consumption. Internationally traded real bonds that are bought in period t yield a net real interest rate of r_t . Each individual receives an exogenous endowment y_t , and is subject to a lump-sum tax of τ_t . Money services are produced by domestic and foreign real balances in a constant elasticity of substitution (CES) production function:

$$x_t = \gamma \left[\alpha \left(\frac{m_t}{p_t} \right)^{-\rho} + (1 - \alpha) \left(\frac{m_t^*}{p_t^*} \right)^{-\rho} \right]^{-1/\rho}. \quad (9)$$

Finally, the government finances some part of the real deficit g_t by imposing an inflation tax. The government budget constraint is given by

$$g_t = \tau + \frac{M_t - M_{t-1}}{P_t}. \quad (10)$$

The government determines the nominal amount of seigniorage by selecting a value for the nominal growth rate of money. However, real seigniorage is basically determined by the optimizing behavior of the representative agent. Suppose that the utility function of the representative agent is given by

$$U(t) = \frac{\left(c_t^\alpha x_t^{1-\alpha} \right)^\theta - 1}{\theta}. \quad (11)$$

Let

$$z = \alpha \left(\frac{m_t}{p_t} \right)^{-\rho} + (1 + \alpha) \left(\frac{m_t^*}{p_t^*} \right)^{-\rho}.$$

Imrohoroglu (1996) shows that the following equations may numerically be solved to obtain the deterministic steady-state values of c , m/p , and m^*/p^* as a function of the parameters of preferences, technology, and government policies,

$$\alpha(1-\rho)z^{-1}\left(\frac{m_t}{p_t}\right)^{-1-\rho} + \beta\sigma c^{-1}(1+\pi)^{-1} - \sigma c^{-1} = 0, \quad (12)$$

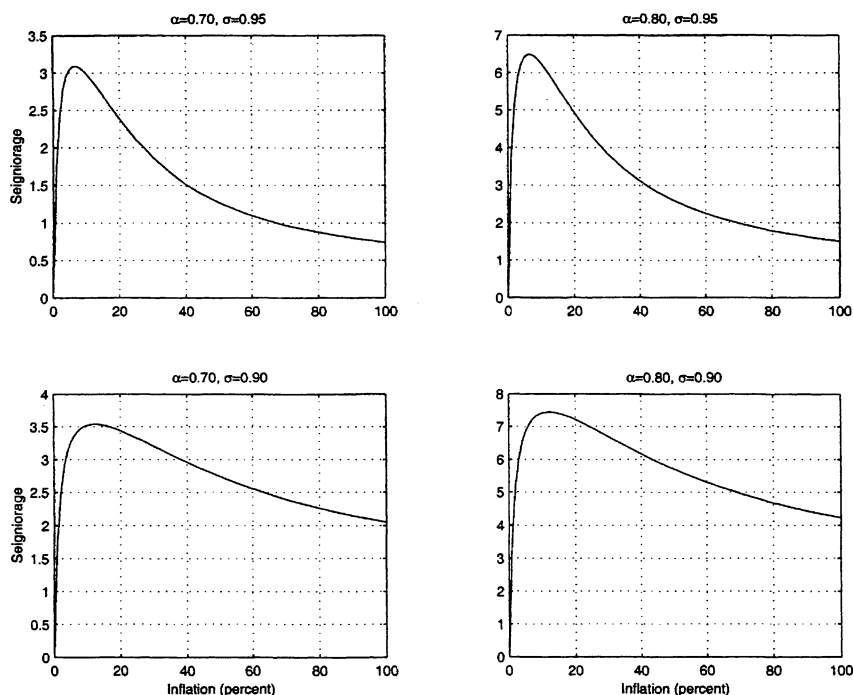
$$(1-\alpha)(1-\rho)z^{-1}\left(\frac{m_t^*}{p_t^*}\right)^{-1-\rho} + \beta\sigma c^{-1}(1+\pi^*)^{-1} - \sigma c^{-1} = 0, \quad (13)$$

$$y - g - c - \frac{\pi_t^*}{1 + \pi_t^*} \frac{m_t^*}{p_t^*} = 0, \quad (14)$$

where $\pi = (p_{t+1} - p_t)/p_t$, and $\pi^* = (p_{t+1}^* - p_t^*)/p_t^*$. Equations (12) and (13) are derived from standard Euler equations. Equation (14) represents the constraint faced by the economy.⁵

In order to estimate the state-state values of c , m/p , and m^*/p^* by evaluating Equations (12), (13), and (14), the numerical values of the underlying parameters of preferences, technology, and government policy are required. Based on the stylized facts, it is assumed that $y = 100$, $g = 20$, and $\pi^* = 0.05$. For other parameters, Selçuk (1997) estimated a money-in-utility function model, similar to the one outlined in the previous section for the Turkish economy. Selçuk (1997) showed that the elasticity of substitution between domestic and foreign balances is high and significant and that the share of foreign real balances in producing domestic liquidity services is relatively high and statistically significant. The values of estimated parameters in that study are $\beta = 0.9865$, $\alpha = 0.703$, and $\rho = -0.65$. The last parameter implies an elasticity of currency substitution of 2.86, whereas the second parameter sets the share of foreign balances in producing liquidity services to 30 percent. The share of money services in the utility function $(1 - \sigma)$ is assumed to be at 0.05. Given those parameters, real seigniorage revenue is calculated for each inflation rate π between 0.01 and 1.0 with increments of 0.01. The results are reported in Figure 3 for different parameter settings. In general, the seigniorage Laffer curve reaches to the maximum right after the exogenously given world inflation rate of 5 percent. After this rate, the seigniorage falls and approaches a lower limit and inflation goes to infinity. Given a high elasticity of currency substitution and a reasonable share of foreign real

Figure 3. Annual Inflation and Seigniorage Estimates from the Numerical Evaluations of Euler Equations in Equations (12), (13), and (14)



Note: The share of money services in the utility function is $(1 - \sigma)$ and α is the share of domestic real balances in producing domestic liquidity services.

balances in producing domestic liquidity services, the results show that the Turkish government cannot collect more seigniorage revenue by simply increasing monetary base growth and, consequently, inflation. Therefore, it is not surprising that there is no observed linear relation between the seigniorage and inflation in Turkey.

The significance of money services in the utility function plays an important role in seigniorage collection. If the share of money services in the utility function is higher (smaller value of σ), the government is able to collect more seigniorage revenue at a given inflation rate. Holding everything else constant and setting $\sigma = 0.90$ results in a higher seigniorage Laffer curve in Figure 3. The implication is that a less-developed financial sector (in terms of limited usage of checking accounts, credit cards, and so on) gives an opportunity to collect more seigniorage revenue through money creation and inflation.

The share of foreign real balances in producing domestic liquidity services is another important factor in the determination of the maximum seigniorage. Holding everything else constant, the share of foreign balances is reduced to 20 percent ($\alpha = 0.80$) from the previous (estimated) 30 percent. The resulting Laffer curves are given in the right panel of Figure 3. The results show that the seigniorage revenue for every level of inflation increases after a decrease in the share of foreign real balances. Also, the seigniorage-maximizing level of inflation becomes higher although the shape of the seigniorage Laffer curve does not change much.

Conclusion

The central message of the numerical exercises of Euler equations based on the estimated parameters from the Turkish economy is a clear one: As long as there is some degree of currency substitution in the economy, the Turkish government cannot collect more seigniorage revenue by simply setting the growth rate of the monetary base at a higher level. Contrary to the findings of conventional studies on the subject, if foreign real balances produce some liquidity services in the economy, the seigniorage-maximizing level of inflation in Turkey cannot deviate from the world inflation. The result also implies that the Turkish economy is always on the wrong side of the seigniorage Laffer curve as long as the domestic inflation is higher than the world inflation and there is some degree of currency substitution. This result has important policy implications in conducting a stabilization program. If a stabilization program is implemented vigorously so that the steady-state level of inflation is closer to the world inflation, it is very likely that the real seigniorage revenue will increase significantly.

Notes

1. See Ertuğrul (1982) for a macroeconometric analysis of fiscal deficit, money stock, and inflation in Turkey during the 1970s. Önis and Özmucur (1990) investigate the inflation dynamics in Turkey under the vicious cycle hypothesis. For the relationship between inflation and the budget deficit in the Turkish economy including more recent data, see Lim and Papi (1997), Metin (1995, 1998), and the references therein.

2. Sometimes it is argued that currency substitution may provide inflation discipline (Canzoneri and Diba 1992; Fisher 1982). However, it cannot be a substitute for a sound fiscal and monetary policy, lacking in chronic, high inflation economies. See Giovannini and Turtelboom (1994) for a detailed survey on currency substitution. Végh (1989) examines the effect of currency substitution on inflationary finance and seigniorage. Melvin and Peiers (1996) analyze the cost of large seigniorage losses due to dollarization. Akçay et al. (1997) and Selçuk (1994, 1997) investigate the dynamics of currency substitution in Turkey.

3. Derived from the standard seigniorage maximization condition $\varepsilon(\pi + \phi g) + 1 = 0$, where ε is the semi-log elasticity of real money demand with respect to inflation cost of holding money, g is the growth rate of real income, and ϕ is the elasticity of real money demand with respect to real output. Note that the estimate of λ is calculated as $\lambda = b_1/(1 - b_3)$, and the estimate of ϕ is given by $\phi = b_2/(1 - b_3)$.

4. Preliminary investigation revealed that the data series were not stationary. Differencing the series as $x_t - x_{t-4}$ eliminated the high seasonality and nonstationarity.

5. Given the development stage of the financial markets in the economy, it is assumed that $b^* = 0$ so that the relevant Euler equation drops out.

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